Lastly, in the right hand column of Table 6 I again do IV estimation allowing for both price and regulation to be jointly endogenous. The IV results remain very similar to the previous results. The estimated price elasticity is -0.50 and the effect of regulation, apart from price, is estimated to be -14.8%. Thus, regulation is found to have both significant price and non-price effects on cellular penetration.

VI. Estimation of the Overall Effect of Regulation on Consumer Welfare

Cellular output is lower in regulated states with the main reason for this result being consumer response to the higher prices in regulated states. This outcome of higher prices and lower output because of regulation demonstrates that regulation harms cellular consumers. While regulators such as the CPUC may have other goals such as protection of resellers or may have problems in believing that unregulated markets operate better than regulated markets, the market evidence is quite clear. Regulation of cellular telephone harms consumers.

To estimate the overall effect on consumer welfare, I use an exact consumers surplus approach using the expenditure function for the log linear demand curve used in Table 6. First, I use the expenditure function calculated in Hausman (1981), equation (23):

$$e\,(p,\overline{u}) = [\,(1-\delta)\;(\overline{u}+Ap^{1+\alpha}/(1+\alpha))\,]^{1/(1-\delta)} \qquad (1)$$

where A is the intercept of the demand curve, α is the price elasticity, and δ is the income elasticity estimate in Table 6. The compensating variation is calculated from equation (1) where y is income:

$$CV = \left\{\frac{(1-\delta)}{(1+\alpha)}\;y^{-\delta}\;[p_1x_1-p_0x_0]\;+\;y^{(1-\delta)}\right\}^{1/(1-\delta)} - y \qquad (2)$$

The calculation of the compensating variation from equation (2) created by regulation is \$238.82 per year, or estimated for California the amount is \$477.6 million per year for the entire California population which includes cellular customers who pay higher prices and lost consumer's surplus for individuals who would purchase cellular at the lower non-regulated price.

The expenditure function can also be used to calculate the lost consumer welfare from the non-price effects of regulation. Here I consider an increase in the intercept coefficient A from the demand curve in equation (1) by 14.8% which is the estimate of the non-price effect of cellular regulation. Note that this calculation is not strictly correct based on the original indifference map because the outward shift of the demand curve causes two different indifference maps to be compared.[26] The approach I take to allow comparison of similar indifference maps is to solve for the change in price which would cause the 14.8% non-price shift in demand and to calculate the compensating variation from this price decrease using equation (2). When I use the change in price which would cause a 14.8% increase in demand, I find that consumers surplus would increase in California by about 1.97 times as much as the effect of lower prices. On a California wide basis I calculate the overall yearly loss to regulation to be about \$1.41 billion per year.

The last question which I attempt to answer is how much consumer's surplus was lost by the original delay by the FCC in licensing cellular in the US. This regulatory indecision caused a new good, cellular telephone, to be unavailable in the US when it was being offered in Scandinavia and Japan using technology invented by AT&T Bell Labs. I use the methodology first put forward by Hicks (1940) and recently expanded and applied by Hausman (1994). The main idea is to calculate the reservation or virtual price which causes demand for the good to be zero using the expenditure function from equation (1) and the corresponding Hicksian (compensated) demand curve. I only attempt to approximate this welfare loss by asking the question: if cellular had been

[26] This problems from shifts in the demand curve is a common problem in welfare measurements.

available in 1983 with a 10 year history but because of more limited and higher cost microprocessors and other semiconductor chips it cost twice as much (in 1983 dollars) as it does in 1994, what was the lost consumers surplus? I estimate that the lost consumers surplus was approximately $24.3 billion in 1983 dollars or about $33.5 billion in current 1994 dollars. Even if I assume that demand for cellular would only have been 1/2 as great in 1983 because of decreased functionality, I still estimate a welfare loss of approximately $16.7 billion.[27] As expected, the consumer welfare cost of holding up the introduction of a new good is much larger than the effects of higher prices or other regulatory effects on demand, because the entire consumer's surplus is lost when regulatory delays cause demand to be zero.

VII. Conclusion

Cellular telephone's phenomenal success has changed the way that Americans live and work. Mobile communications has been combined with the mobile life style that has characterized the changes in the U.S. economy since WWII. The average 1 hour per day that commuters near large MSAs spend in their cars going to and from work is now increasingly accompanied by the ability to communicate about business matters while commuting. Also, convenient sized portables have led to the ability to find people "anytime and anywhere" (at least in the U.S.). Furthermore, safety and security while driving has increased since drivers have a telephone with them at all times.

Thus, the FCC's cellular policy has been an outstanding success. Arguments about the competitiveness of the duopoly market structure continue; however, I believe that the arguments are fundamentally misguided. The alternative to duopoly competition in cellular has been state PUC regulation of cellular. State PUC regulation of cellular has been a failure since prices are higher and output is lower in states which regulate cellular compared to

[27] Jackson et. al (1991) earlier estimated a welfare loss of about $85 billion from the delay in introducing cellular telephone into the U.S., assuming the delay to be 10 years.

states which don't regulate cellular. Thus, if the duopoly market structure creates a "problem" of the exercise of market power, the attempted cure worsens the disease. State regulation of cellular telephone costs consumers hundreds of millions of dollars per year in the misguided belief of state regulators that protecting competitors, here resellers, is more important than protection of consumers through competition.

This lesson, that duopoly competition can be better than regulation, may become increasingly important in the future when two providers of broadband services compete for residential customers. State regulators <u>assume</u> (as a matter of faith) that their regulation is better than a situation of imperfect competition. No economic theory nor wideranging empirical study supports this assumption. Cellular telephone proves it to be false in this particular industry. Important decisions on the future of one of the two most important and dynamic sectors of the U.S. economy should not be based on false assumptions. Competition, even imperfect competition, usually provides a more pro-competitive outcome and greater consumer welfare than regulation. This lesson should affect economic and policy choices by Congress, the FCC, and state regulators as communication becomes increasingly important to the functioning of our society and to the future of the U.S. economy.

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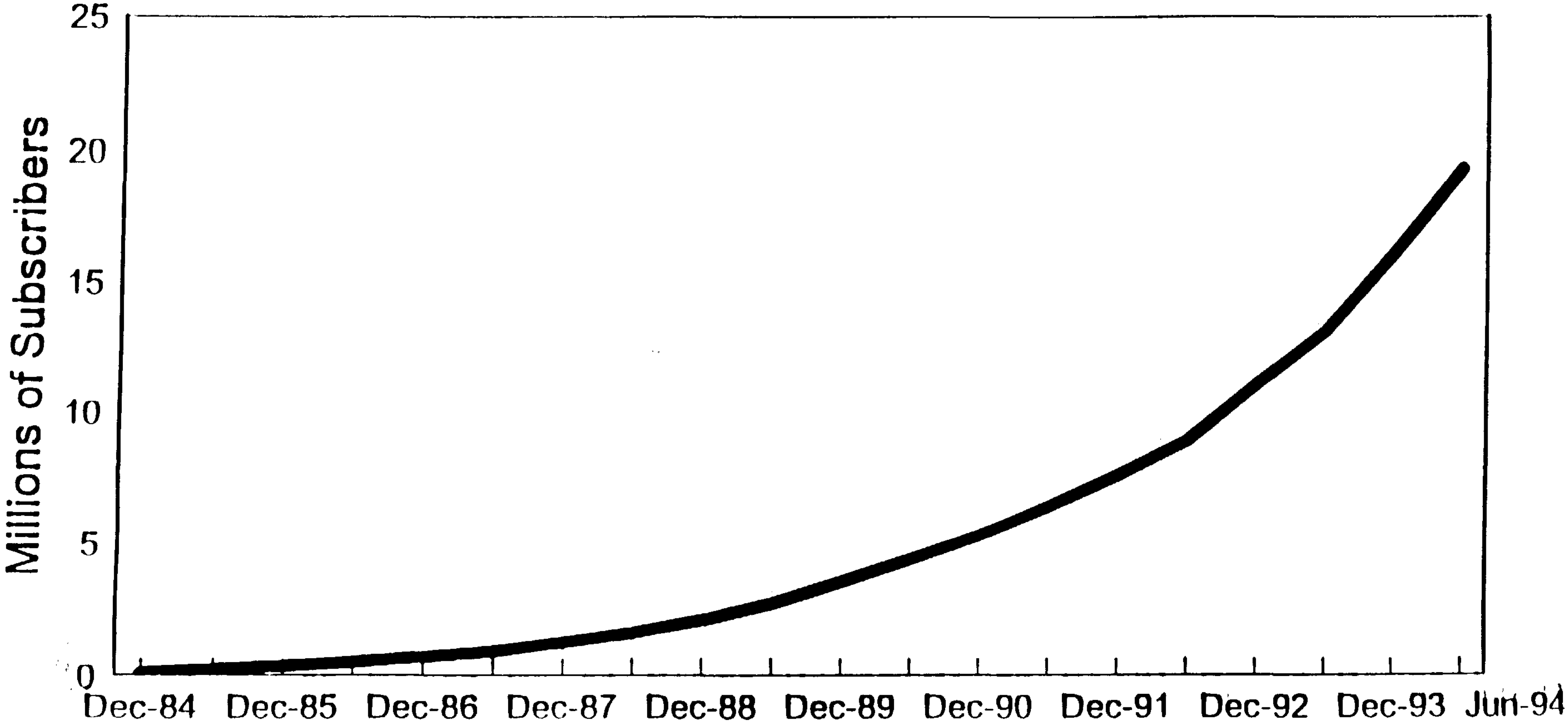
Figure 1

Cellular Subscribers, 1984-1994



Source: CTIA End-of-Year Data Survey

Table 2

1989-93 Price Regression for Top 30 Cellular Markets < 1
Left hand Side Variable: Log of Price at 160 MOU < 2

Variable	OLS	Instrumental Variables < 3
Intercept	4.153 (0.105)	4.129 (0.107)
Log of Commute Time < 4	0.207 (0.101)	0.193 (0.103)
Log of Construction Cost < 5	1.461 (0.457)	1.255 (0.468)
Interaction between Commute Time and Construction Cost	1.669 (0.477)	1.533 (0.485)
Regulation	0.171 (0.029)	0.234 (0.036)
Year 89	0.167 (0.034)	0.163 (0.035)
Year 90	0.120 (0.034)	0.115 (0.034)
Year 91	0.067 (0.033)	0.064 (0.033)
Year 92	0.034 (0.032)	0.033 (0.033)
Number of Observations	198	198
Standard Error of Regression	0.148	0.150
R Squared	0.403	---

Notes:
1 > Standard errors in parentheses.
2 > Minimum monthly bill is based on 128 minutes of peak calling and 32 minutes of off-peak calling.
3 > Instruments include an indicator variable for state regulation of paging, maximum marginal state income tax rates, and state taxes as a percentage of personal income.
4 > Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.
5 > Source: "Boeckh Building Cost Index Numbers".

Table 3

1989-93 Price Regression for Top 30 Cellular Markets < 1

Left hand Side Variable: Log of Price at 250 MOU < 2

Variable	OLS	Instrumental Variables < 3
Intercept	4.601 (0.087)	4.583 (0.088)
Log of Commute Time < 4	0.365 (0.083)	0.355 (0.084)
Log of Construction Cost < 5	1.120 (0.375)	0.971 (0.383)
Interaction between Commute Time and Construction Cost	1.213 (0.392)	1.115 (0.397)
Regulation	0.166 (0.024)	0.211 (0.029)
Year 89	0.189 (0.028)	0.186 (0.029)
Year 90	0.139 (0.028)	0.135 (0.028)
Year 91	0.074 (0.027)	0.071 (0.027)
Year 92	0.042 (0.027)	0.040 (0.027)
Number of Observations	198	198
Standard Error of Regression	0.121	0.123
R Squared	0.543	---

Notes:

1> Standard errors in parentheses.

2> Minimum monthly bill is based on 200 minutes of peak calling and 50 minutes of off-peak calling.

3> Instruments include an indicator variable for state regulation of paging, maximum marginal state income tax rates, and state taxes as a percentage of personal income.

4> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.

5> Source: "Boeckh Building Cost Index Numbers".

1989-93 Price Regression for Top 30 Cellular Markets <1

Left hand Side Variable: Log of Price at 30 MOU <2

Variable	OLS	Instrumental Variables <3
Intercept	3.333	3.281
	(0.160)	(0.164)
Log of Commute Time <4	0.221	0.191
	(0.154)	(0.158)
Log of Construction Cost <5	0.363	-0.078
	(0.693)	(0.718)
Interaction between Commute Time and Construction Cost	0.821	0.530
	(0.723)	(0.745)
Regulation	0.266	0.400
	(0.043)	(0.055)
Year 89	0.021	0.012
	(0.052)	(0.054)
Year 90	0.023	0.012
	(0.051)	(0.052)
Year 91	0.041	0.034
	(0.049)	(0.051)
Year 92	0.047	0.043
	(0.049)	(0.050)
Number of Observations	198	198
Standard Error of Regression	0.224	0.230
R Squared	0.219	---

Notes:

1> Standard errors in parentheses.

2> Minimum monthly bill is based on 24 minutes of peak calling and 6 minutes of off-peak calling.

2> Instruments include an indicator variable for state regulation of paging, maximum marginal state income tax rates, and state taxes as a percentage of personal income.

3> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.

4> Source: "Boeckh Building Cost Index Numbers".

Table 6

1989-93 Demand Regression for Top 30 Cellular Markets < 1
Left hand Side Variable: Log of Subscribers

Variable	OLS	IV 1 <2	IV 2 <3
Intercept	0.852 (2.475)	1.101 (2.478)	1.091 (2.478)
Log of Price <4	-0.406 (0.151)	-0.506 (0.169)	-0.501 (0.169)
Log of Income <5	0.184 (0.302)	0.193 (0.302)	0.192 (0.302)
Log of Population <6	0.948 (0.064)	0.953 (0.064)	0.953 (0.064)
Log of Commute Time <7	0.977 (0.356)	0.984 (0.355)	0.983 (0.355)
Regulation	-0.161 (0.065)	-0.147 (0.066)	-0.148 (0.066)
Year 89	-1.234 (0.090)	-1.217 (0.091)	-1.218 (0.091)
Year 90	-0.830 (0.078)	-0.817 (0.078)	-0.818 (0.078)
Year 91	-0.566 (0.071)	-0.559 (0.071)	-0.559 (0.071)
Year 92	-0.310 (0.069)	-0.306 (0.069)	-0.307 (0.069)
Number of Obs.	196	196	196
Std. Error of Reg.	0.315	0.315	0.315
R Squared	0.982	—	—

Notes:

1> Standard errors in parentheses.
2> Price is endogenous. Instruments include average price across other Top 30 MSAs, an indicator variable for state regulation of paging, maximum marginal state income tax rates, state taxes as a percentage of personal income, and construction costs.
3> Price and regulation are endogenous. Instruments included are listed above.
4> Minimum monthly bill is based on 128 minutes of peak calling and 32 minutes of off-peak calling.
5> Log of per capita personal income. Source: NPA Data Services, Inc., April 1994.
6> Log of population. Source: NPA Data Services, Inc., April 1994.
7> Mean commute time from home to work. Source: 1990 U.S. Census, Tape File 3c.